APPENDIX E

FILTRATION EQUIPMENT

E-1. Collective Protection System Design.

If the CP filtration system is located in a contaminated environment; i.e., outside the TFA envelope, the CP filtration system will be designed as a blow-through system with the blower located before the CP filtration system. If the CP filtration system is located in a clean environment; i.e., inside the TFA envelope, and draws in the contaminated air through a ductwork system, it will be designed as a draw-through system with the blower located after the CP filtration system. The CP filtration system blower total static pressure will be designed to include the filtration system with dirty filters, ductwork system pressure losses, and the overpressure requirement of the TFA.

E-2. Filtration Systems.

The filtration system is the most critical part of the CP overpressure system. A number of filtration systems are available from both the military and commercial suppliers. If commercial filter systems are used, the mechanical system designer should have the technical expertise to prepare specifications that meet military filter system requirements. For continuously operated filter systems, accessory equipment such as moisture eliminators and large particulate filters will be considered for protection of the filter system.

a. *Military Filtration Systems*. Military filtration units are typically provided as Government-furnished equipment (GFE). Military equipment provided as GFE has the advantage of being pre-approved for use on Government installations, while commercially available equipment requires additional Government quality testing.

(1) Fan Filter Assembly (FFA) 580. The FFA-580 filtration unit provides chemical filtration with a designed capacity of 283 L/s (600 cfm) at 3,750 Pa (15.0 inches wg) using a 2.24-kW (3-HP) motor. The FFA-580 contains a HEPA filter and an ASZM-TEDA carbon adsorber designed for a residence time of 0.25 seconds. The FFA-580 is designed for standby operation and is not intended for continuous duty.

(a) Air Tempering. The FFA-580 unit does not provide air tempering of the filtered air. For Class I and II facilities, the filtered air can be either ducted directly into the facility air handling unit return ductwork or discharged directly into the TFA. The existing mechanical system provides tempering of the air and must be located within the TFA envelope. If the FFA-580 unit is used to pressurize Class III facilities, the filtered outside air will be discharged directly into the TFA and the TFA temperature will approach outside ambient conditions.

(b) Filtered Airflow Rate. The FFA-580 is provided with an adjustable iris valve (variable diameter orifice) at the blower inlet. The iris valve is used to maintain the airflow rate for differing field conditions and will be field adjusted to maintain a maximum airflow rate of 311 L/s (660 cfm). Adjusting the FFA-580 unit for this airflow rate allows the unit to maintain the minimum 283 L/s (600 cfm) airflow rate when the HEPA filter becomes slightly loaded with dirt and atmospheric dust. Airflow rates above 311 L/s (660 cfm) should be avoided because higher airflow rates reduce filter adsorption capacity and residence time. The FFA-580 unit does not have a prefilter and therefore the HEPA filter will load more quickly than a filtration system with a prefilter. The FFA-580 unit requires periodic airflow testing to ensure it is maintaining an airflow rate in the range of 283 L/s (600 cfm) to 311 L/s (660 cfm). An airflow rate of 283 L/s (600 cfm) will be used for design of the overpressure filtered air system and an airflow rate of 311 L/s (660 cfm) will be used to design the HVAC system heating and cooling loads. The FFA-580 blower unit can be used for both 50 and 60 Hz power supply. This will result in different airflow rates and static pressure values and needs to be considered in the facility design. The FFA-580 blower will produce a calculated temperature rise of 4.4 degrees C (8.0 degrees F) at standard conditions. Actual tested conditions to determine the air temperature rise across the blower unit indicated in certain conditions the air temperature rise can be higher than the calculated value. It is recommended that a temperature rise of 5.5 degrees C (10 degrees F) be used across the FFA-580 blower unit.

(2) The M49 Adsorption Filter. The M49 adsorber is a military developed and produced gas adsorber. Quality control and testing is also provided and managed by the military. The M49 filter comes in two sizes: 283 L/s (600 cfm) and 566 L/s (1,200 cfm). The M49 adsorber is of modular design and can be stacked in multiples to achieve a higher airflow rate. When compared to commercially available adsorber filters, the M49 requires only one stage of filtration for an airflow rate of 566 L/s (1,200 cfm). Therefore, using the M49 will require somewhat less floor space than a commercial filter system. The M49 pressure drop is approximately 1,750 Pa (7 inches wg) lower than a comparable commercially available filter. The lower static pressure drop results in less initial blower cost due to the lower static head requirement. For CP filtration systems that operate continuously, the lower static pressure drop of the M49 results in lower operating costs. However, for CP systems that operate only when needed, the energy cost savings will be minor. The M49 carbon trays are refillable by the Government. The disadvantage of the M49 filter is its relatively high initial cost compared to commercially available filters. The M49 adsorption filter requires prefilters, HEPA filters, and test sections or test points similar to commercial filter systems. To procure the M49 filter, contact the Technical Director, U.S. Army Edgewood Research, Development and Engineering Center, ATTN: SCBRD-ENP-A/ Fixed Installation Engineer, 5183 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5423.

b. *Commercial Filtration Systems*. Commercial filtration systems are of modular sectional design and each section can filter 165 L/s (350 cfm) to 590 L/s (1,250 cfm) with two stages of adsorption. The CP overpressure filter system will require, in series, the following filter sections: roughing filter, prefilter, an initial HEPA filter, either one or two stages of adsorbers, and a final HEPA filter. The actual type and number of filters required will depend upon what is to be

filtered. Test sections can be provided with the filtration system to ease in-place leak testing of the system, isolate which filter section fails the leak test, and for future leak testing of the filter system. To test the carbon adsorbers, typically testing injection and sampling ports that are located before and after the filter system will be adequate in testing a single stage adsorption system. To test two stages of adsorption, a test section will be required between the stages. To test HEPA filters, test sections will be required for sampling after the HEPA filter. Test ports must be placed at a location where good mixing will occur or the test ports must be located approximately 10 duct diameters before and after the filter system. The filter system will be quality assurance tested in accordance with ASME N510 and MIL-PRF-32016(EA). Current commercial filtration systems are of nuclear grade safety class design and are designed for use primarily by the nuclear industry. The commercial filtration systems meet quality assurance requirements for nuclear facility applications (ASME NQA-1) and generic seismic requirements in IEEE Standard 344. Commercial filtration systems used for certain applications, primarily for containment, warrant the use of ASME NQA-1 and IEEE 344.

(1) Filter Housing. The filter housing will be a bag-in and bag-out design conforming to the applicable sections of ASME N509 and will be constructed of type 304 stainless steel. For applications where contaminants will be continuously filtered, bags for the bag-in and bag-out ports will be provided. For applications where contaminants will rarely be filtered, bags for the bag-in and bag-out ports are not required.

(2) Roughing Filter. Continuously operated filter systems will have a roughing filter with an average efficiency of 25 to 30 percent when tested in accordance with ASHRAE 52.1. The roughing filter extends the life of the intermediate filter or prefilter and reduces its change frequency.

(3) Prefilter. The prefilter or intermediate filter will have an average efficiency of 80 to 85 percent when tested in accordance with ASHRAE 52.1. The prefilter extends the life of the HEPA filter and reduces its change frequency.

(4) HEPA Filter. The HEPA filter frame and filter media will meet the construction, material, testing, qualification, and documentation requirements of ASME N509, ASME N510, and UL 586 and will have a filter efficiency of 99.97 percent at a 0.3 Fm diameter particle size when tested in accordance with the MIL-STD-282 dioctyl phthalate (DOP) test method. The filter frames will meet the requirements of ASME AG-1a, Section FC. The HEPA filter medium will meet the requirements of MS MIL-F-51079D.

(5) Adsorption Filter. The adsorber charcoal media will be designed to adsorb aerosol with a minimum residence time of 0.25 seconds and will meet the requirements of MIL-PRF-32016(EA). Typically, for commercial filters, two stages are required to achieve the 0.25 second residence time at airflow rates of 330 L/s (700 cfm) to 590 L/s (1,250 cfm). One stage of filteradsorption can be used for airflow rates from 165 L/s (350 cfm) to 295 L/s (625 cfm). For unknown threats and adsorption of volatile agents, ASZM-TEDA carbon conforming to EA-C-

1704 will be used. If the threat is known, the use of ASZM-TEDA may not be required. This will depend upon the chemical volatility of the threat. If agents of higher volatility, such as hydrogen cyanide and cyangen chloride are not a threat, activated carbon (not impregnated carbon) will suffice. The static pressure drop through an ASZM-TEDA adsorber that meets the requirements of MIL-PRF-32016(EA) is approximately 625 Pa (2.5 inches wg) for a 235 L/s (500 cfm) adsorber. A sample of the ASZM-TEDA carbon must be provided by the filter manufacturer for testing at the U.S. Army Edgewood Research, Development and Engineering Center (ERDEC) as stated in MIL-PRF-32016(EA). Funding for ERDEC testing is provided by the user. Filter trays not contaminated by chemical surety materials or by super toxic materials can be refilled by the manufacturer, but any contaminated carbon must be disposed of by the owning activity in accordance with local, state, and federal regulations. A license must be obtained from the U.S. Department of Commerce before an adsorption filter containing ASZM-TEDA carbon can be shipped outside the United States.